INSTRUCTION MANUAL

DC-210B

PRECISION STANDARDS CORPORATION

PSC

1701 Reynolds • Santa Ana, Calif. 92705 • (714) 546-0431

PRECISION INSTRUMENTS FOR SCIENCE AND INDUSTRY

PRECISION Standards CORP.
1701 REYNOLDS, SANTA ANA, CALIF. 92705

PRECISION DC VOLTMETER

Model DC-210B/BR

Serial_____

PRECISION STANDARDS CORPORATION
1701 Reynolds
Santa Ana, California, Zip 92705
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IMPORTANT

FOR OPTIMUM RESULTS, PLEASE READ THE INSTRUCTION MANUAL CAREFULLY.

This instrument you have purchased represents a major advance in the field of transistorized precision test equipment.

Since this instrument incorporates the latest engineering techniques and design, it is imperative that you become familiar with the proper operating procedure.

Meter zeroing adjustment is performed at the factory. Normally no further adjustment is required. Should adjustment be necessary, the meter may be zeroed by the mechanical adjustment screw on the meter itself while the instrument is operating.

OPERATING INSTRUCTIONS

1. The line cord should be plugged into a 117-volt 60-cycle power source. (220 volt if indicated)
2. Turn the null selector to TVM position and power switch on. Let the instrument warm up for approximately 10 minutes.
3. Check mechanical zero of meter. If necessary, adjust to zero by means of the screw in the center of the meter case.
4. Turn the range selector knob to the desired range. Connect the voltage to be measured to the terminal posts. Either positive or negative may be grounded to the common terminal. When operating with the polarity switch in the positive mode, the negative terminal is generally grounded to the case or left floating and in the negative mode, the reverse.
5. The voltage now indicated on the meter is accurate within 4%. If the meter needle swings to the left, turn the polarity switch to the NEG position.
6. Position first two readout dials to the approximate TVM voltage reading. Advance the null selector knob to the 1 V position. Continue to adjust the readout while increasing the null sensitivity. You are now zeroing in on the null.
7. When, by the procedure above, the null selector is at full sensitivity (1 MV) and the meter reading zero, the voltage read from the dials is accurate to better than the rated accuracy of the instrument. Because the sensitivity of your instrument in the 1 MV null position is higher than the stability of many sources, you may not get a reading of zero if the voltage you are measuring is not constant and is fluctuating.

OPERATING INSTRUCTIONS (Continued)

READING EXCURSIONS ABOUT A NOMINAL VOLTAGE

8. To read excursions of voltage about a nominal value, set the readout dials to the nominal value. Excursions may be observed directly on the meter on any of the four null ranges. A right hand deflection of the meter indicates the voltage has increased above the nominal value by the amount indicated on the meter. For voltages read on the 10-volt range and below, use null sensitivity selector as marked. On the 100-volt ranges, the null sensitivity selector value must be multiplied by a factor of 10. On the 1000-volt range the null sensitivity selector value must be multiplied by a factor of 100.

DIRECT MEASUREMENTS OF 10 VOLTS AND ABOVE

9. With the range selector in the 10-volt position, use full scale values as marked on the meter. When range selector is in the 100-volt position, multiply the meter reading by 10. On the 1000-volt range, multiply the reading by 100.

VARIATIONS IN NULL DETECTOR SENSITIVITY

10. Due to the circuit design on the 100-volt range, the null detector will have reduced sensitivity on the 1 mv and 10 mv positions. This is due to a high internal source impedance of the high voltage input divider. The sensitivity is about 50% less in the 1 mv null position and about 15% less on the 10 mv position. Only a very slight loss of sensitivity is noticed on the other null ranges. When the range selector is in the 1000-volt position, a 10% loss of sensitivity will be noticed in the 1 mv position.

The other null ranges will have only a very slight loss of sensitivity.

MEASUREMENTS BELOW 1 VOLT IN DIFFERENTIAL MODE

11. When making measurements below 1 volt, turn Range Selector switch to the 1-volt position. Set null selector to the 1 mv position. Set all readout dials to zero and short positive and negative input terminals together.

12. Now set the mechanical meter adjustment to zero. This will cancel out error due to zero offset between the 1 millivolt range and the VTVM range. Remove short across terminals and proceed with the reading of voltage per paragraphs 4, 5, 6, and 7.

"POS" AND "NEG" POLARITY

13. This instrument is capable of measuring both positive and negative voltages without reversing the input connections, by setting the polarity switch in the correct position.

Under some conditions the reading in the "NEG" position may differ from the "POS" position. This difference is very small in comparison to the rated accuracy of the instrument. Since the instrument is calibrated in the "POS" position, the best accuracy will result when the polarity switch is in this position.

OPERATING INSTRUCTIONS (Continued)

RECORDER OUTPUT

14. Two sets of output terminals are located on the rear of the voltmeter. One set is the recorder output and the other is the Kelvin-Varley output. The output voltage of the recorder output terminals is ±25 mv for a full scale deflection. The output impedance is approximately 200Ω. Any recorder may be used so long as the leakage resistance to the line or ground is better than 10,000 megohms.

When using high speed recorders, it may be necessary to install a filter between the output terminals of the voltmeter and the input of the recorder. The output signal of the voltmeter will have the demodulated chopper signal and must be filtered out. Generally a three-stage RC filter using 33K resistors and 1 mfd capacitors will be sufficient.

KELVIN-VARLEY OUTPUT

15. The second set of terminals provide an output from the Kelvin-Varley Divider. The maximum output is 10 vdc when the instrument range selector is in the 10-volt position. A chart showing the output impedance of the KVD is located in the back of this manual.

CIRCUIT DESCRIPTION

This Calibration Standards Corporation Voltmeter is completely transistorized and designed for long, trouble-free life. There are no batteries or components that would normally need replacing.

This dependable voltmeter operates on the principle of comparing an unknown voltage with an adjustable known voltage. A sensitive null detector is used to provide a means of sensing when the known and unknown voltages are equal.

This Calibration Standards Corporation Voltmeter is composed of three basic elements:

(1) An ultra stable reference supply.

(2) An accurate Kelvin-Varley divider.

(3) A sensitive null detector.

CIRCUIT DESCRIPTION (Continued)

1. The heart of the voltmeter is the ultra stable reference voltage supply. This supply is a dual regulated transistor supply powering a compensated Zener reference string. The transistors and Zener diodes are silicon, and therefore will withstand high temperatures without impairing the life of the assembly. Following is a performance chart of the references.

Model	Regulation for 10% line change 15°C to 40°C	Temperature Coefficient	Long-term stability of Zener Element Typical	Maximum
DC-210B/BR	±0.001%	*	±10 ppm	±20 ppm
DC-200B/BR	±0.001%	±2 ppm/°C	±10 ppm	±20 ppm
DC-150B/BR	±0.001%	±3 ppm/°C	±10 ppm	±20 ppm
DC-110B/BR	±0.002%	±5 ppm/°C	±20 ppm	±40 ppm

This reference voltage supply is constructed as a printed circuit assembly. Spares and replacements are available from the factory. When ordering, be sure to indicate the serial number of the instrument.

*The Zener reference is enclosed in a proportional control oven holding the temperature to better than ±0.1°C.

CIRCUIT DESCRIPTION (Continued)

2. The second basic element is the very accurate Kelvin-Varley Divider. All readout decks except the last have 11 carefully matched precision wire-wound resistors. The chart below shows the maximum Kelvin-Varley divider linearity and yearly stability.

Model	Linearity	Maximum Stability	Typical Stability
DC-210B/BR	±20 ppm	±5 ppm	±1-2 ppm
DC-200B/BR	±20 ppm	±5 ppm	±1-2 ppm
DC-150B/BR	±25 ppm	±5 ppm	±1-2 ppm
DC-110B/BR	±75 ppm	±20 ppm	±3-5 ppm

Since the divider resistors operate at very low power ratings, the long-term stability of the divider is that of the long-term ratio stability at shelf-life. The resistors are preaged and tested for best stability before installation in the instrument.

The resistors used in the first deck of the DC-210B/BR, DC-200B/BR, and DC-150B/BR Kelvin-Varley Divider are the most stable type of resistor possible to manufacture. They are wound with very little strain and are sealed in silicon oil. Resistors of this type are also utilized in the range divider network.

The range selector precedes the Kelvin-Varley Divider. Each range has a fine adjustment potentiometer for calibration. Each is calibrated separately.

CIRCUIT DESCRIPTION (Continued)

3. The third element is a very sensitive and stable calibrated null detector. This null detector is used to indicate the difference between an unknown external voltage and a known internal voltage. At maximum sensitivity the null detector has a full-scale deflection of 1 mv. This provides ample sensitivity for accurate low-level voltage measurements. The TVM accuracy is ±4% of full scale over a temperature range of 10°C to 40°C. The instrument is usable to 50°C but some derating should be considered.

The null detector is capable of a long, trouble-free life except for the occasional replacement of the chopper. These are highly reliable, however, do occasionally need replacement. Choppers are available from stock at the factory. The occasional calibration of the null detector may be made by adjusting the gain-adjustment potentiometer, R32, located in the amplifier printed circuit board. An electrical zero control, R31, is also located on this board.

The null detector is capable of large overloads without damage. On the 1 mv range a safe overload would be 50 volts short-term and 10 volts long-term. On the 10 mv, 100 mv, and 1V positions, a safe overload of 500 volts is possible.

CIRCUIT DESCRIPTION (Continued)

In the VTVM position ranges, safe overloads are as follows.

1-volt range:	70 volts
10-volt range:	250 volts
100-volt range:	700 volts
1000-volt range:	1500 volts

CALIBRATION

Refer to "Suggested Calibration Set-up" diagram.

A. CALIBRATION OF THE DIFFERENTIAL SECTION

The "RANGE SELECTOR" - "10V" range is calibrated first. On this range the instrument has an infinite input resistance at null.

1. Check mechanical zero of meter. If necessary, adjust to zero by means of the screw in the center of the meter case.
2. Next, turn "NULL SELECTOR" to the TVM position and power switch on. Check electrical zero of meter. If necessary, adjust to zero by means of R31.
3. Apply a known 10-volt calibration voltage across the "POS" and "NEG" input terminals. The instrument meter should read full scale. Turn "READOUT" dials to read (9). (9) (9) (9) (10) and turn "NULL SELECTOR" switch to the "1 MV" position. Bring meter to zero by adjusting the appropriate calibration trim potentiometer. (See calibration board component layout.)
4. Repeat the basic procedure for calibration of the "1V" range using a known 1 volt. Repeat the basic procedure for calibration of the "'00 mv" range using a known 100 mv source. (Omit where not applicable.)
5. The "RANGE SELECTOR" - "100V" and "1000V" ranges are calibrated next. On these ranges the instrument has a 2 megohm input resistance.
6. Turn the "RANGE SELECTOR" switch to the "100V" position and apply a known 100-volt calibration voltage at meter input. Continue basic calibration procedure outlined in Paragraph 3.

   Note: Multiply "NULL SELECTOR" ranges by 10.

CALIBRATION (Continued)

7. Turn the "RANGE SELECTOR" switch to the "1000V" position. Apply a known 500 volts with the "READOUT" dials turned to (5) (0) (0) (0) (0) (0). Bring meter to zero by adjusting the appropriate trim potentiometer.

B. CALIBRATION OF THE TVM RANGES

Calibrate the TVM Ranges by setting the "RANGE SELECTOR" switch to the "10V" position and apply a known 10-volt calibration voltage. Adjust potentiometer R32 for full-scale deflection. It is not necessary to calibrate the remaining TVM ranges.

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W A R R A N T Y

The PRECISION STANDARDS CORPORATION warrants each instrument to be free from defects in material and workmanship. The instrument must be returned to the factory with shipping prepaid and a complete report of the difficulty. This warranty is good for one year from the shipping date.

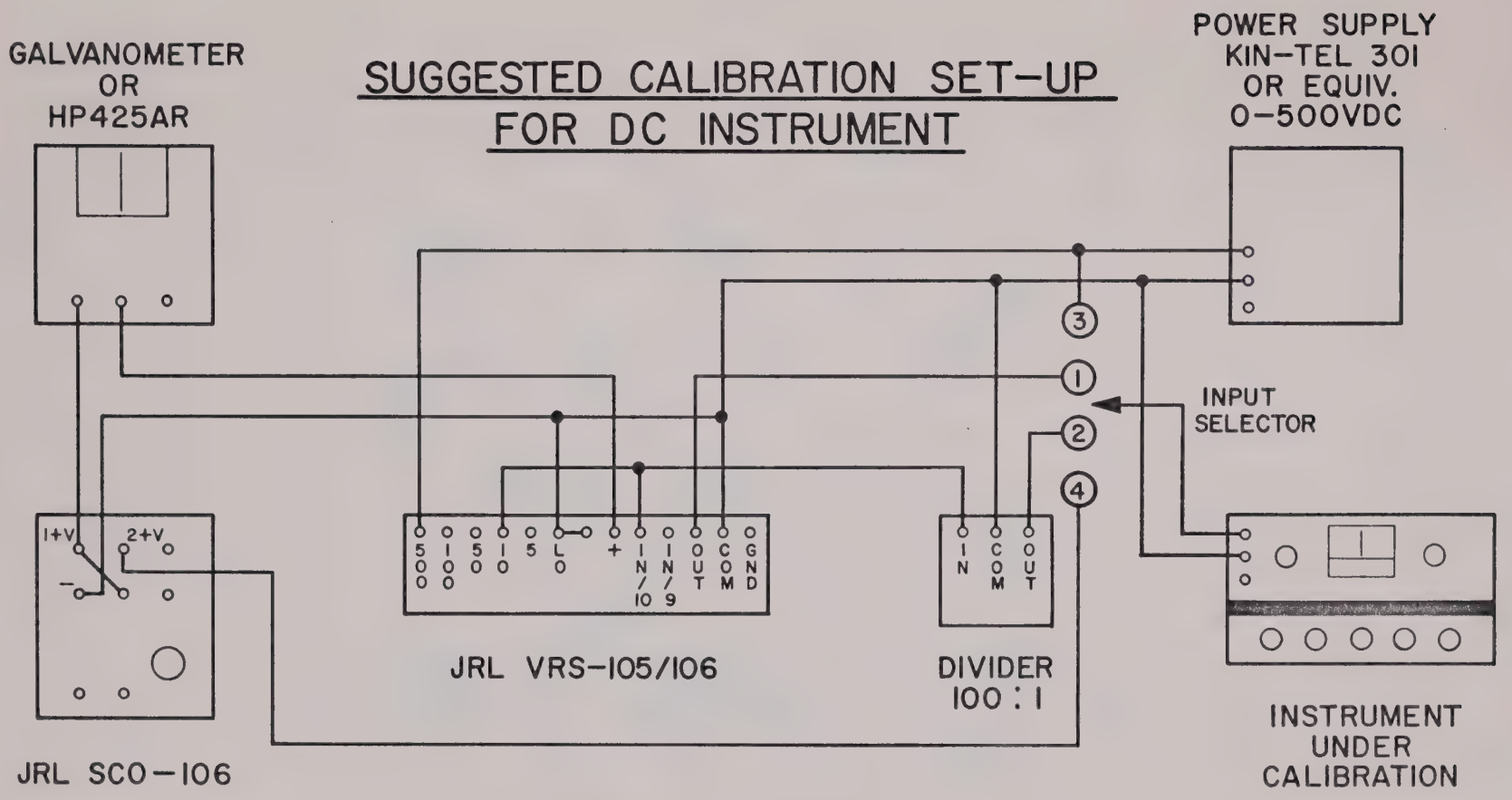
S H I P P I N G D A M A G E

If there is any damage to the instrument upon receipt, report this to the transportation claim agent immediately.

JULIE RESEARCH LABS MODEL SCO-106 CELL ACCURACY 1-2PPM.

JULIE RESEARCH LABS MODEL VRS-105/106 ACCURACY 10PPM CALIBRATOR-10PPM RATIO.

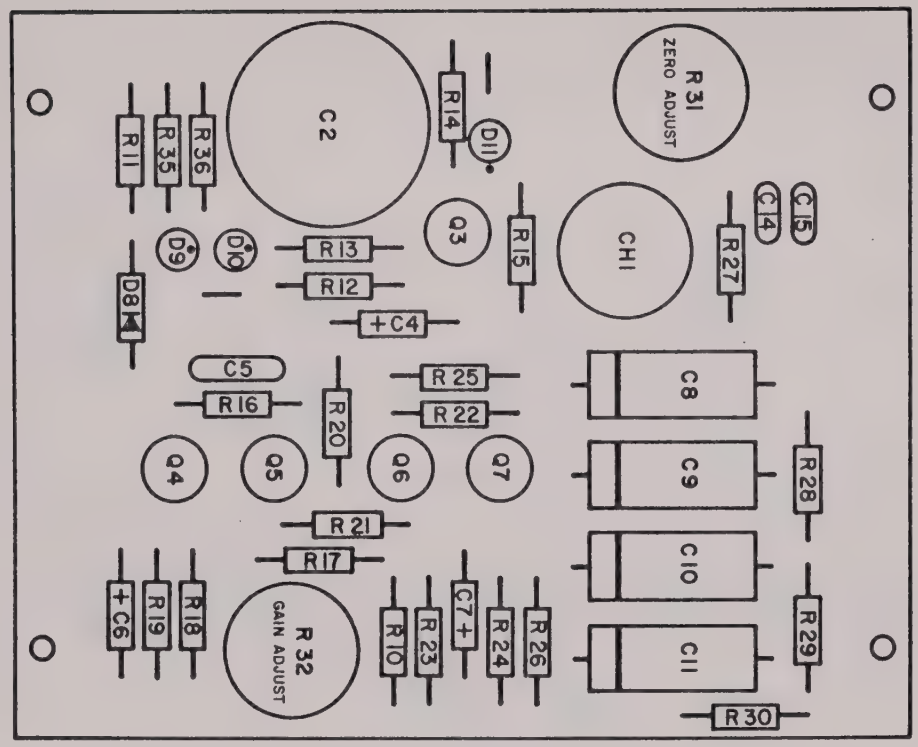
SUGGESTED CALIBRATION SET-UP FOR DC INSTRUMENT



3. CARE SHOULD BE TAKEN WHEN OPERATING INSTRUMENT IN NEGATIVE MODE AS SHORTS MAY DAMAGE OR SHORTEN LIFE OF TEST EQUIPMENT.
2. FOR CALIBRATION OF 100MV RANGE DIVIDER SHOULD BE OF AT LEAST 20PPM ACCURACY.
1. FOR CALIBRATION OF 1.0V RANGE SET RATIO ON DIVIDER (JRL) TO 1.

NOTES:

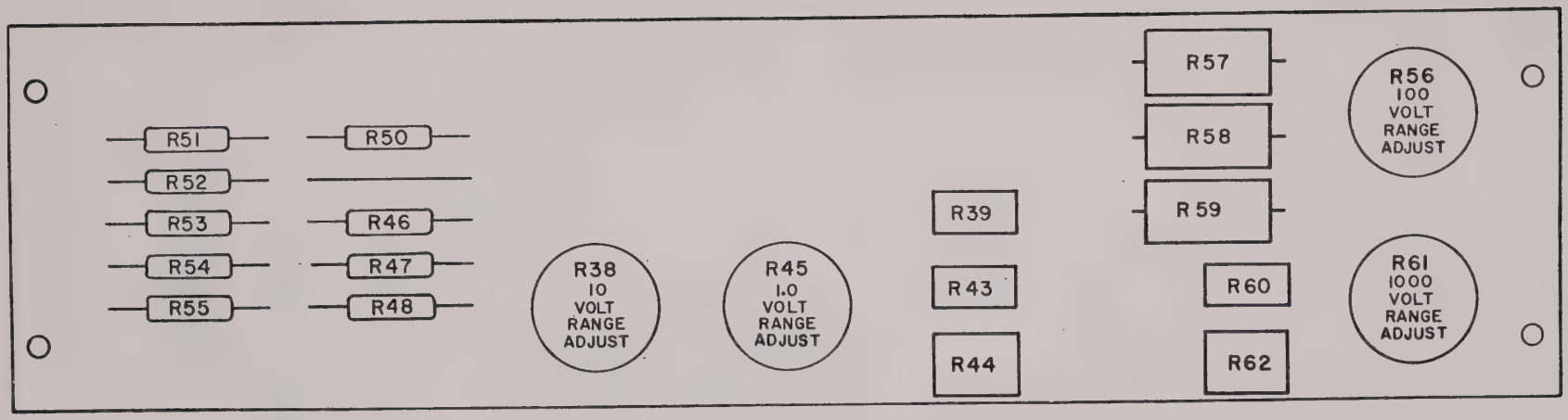
RANGE	INPUT SELECT.	POWER SUPPLY	VRS RATIO	VRS 105
1000V	3	500V	N. U.	500V
100V	3	100V	N. U.	100V
10V	4	10V	N. U.	10V
1.0V	1	10V	10 : 1	10V
100MV	2	10V	N. U.	10V



COMPONENT LOCATION AMPLIFIER

400-106

(REVISION A)

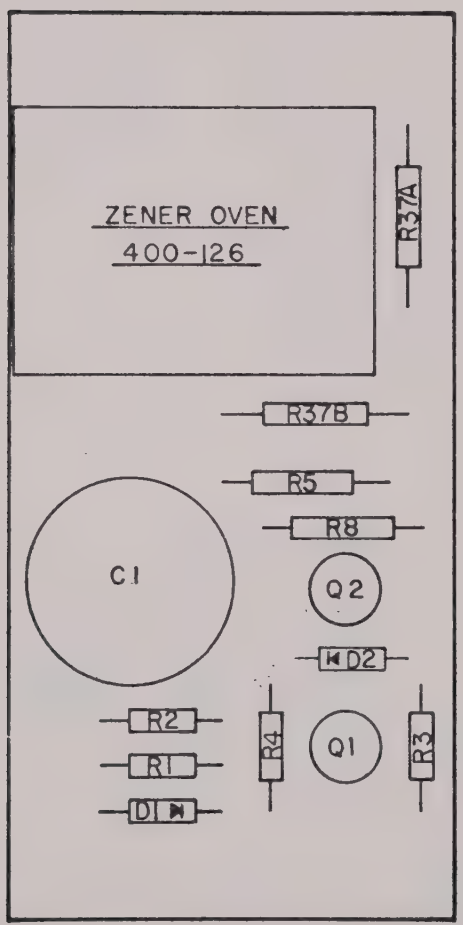


COMPONENT LOCATION CALIBRATION

400—108

(REVISION A)

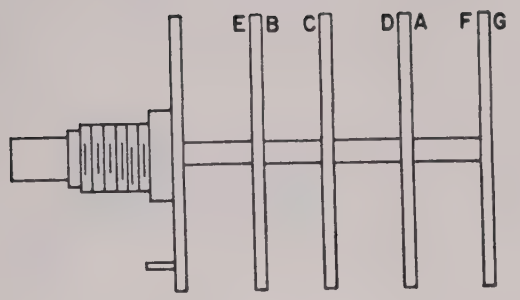
R37 MAY BE COMPOSED OF
ONE OR TWO RESISTORS



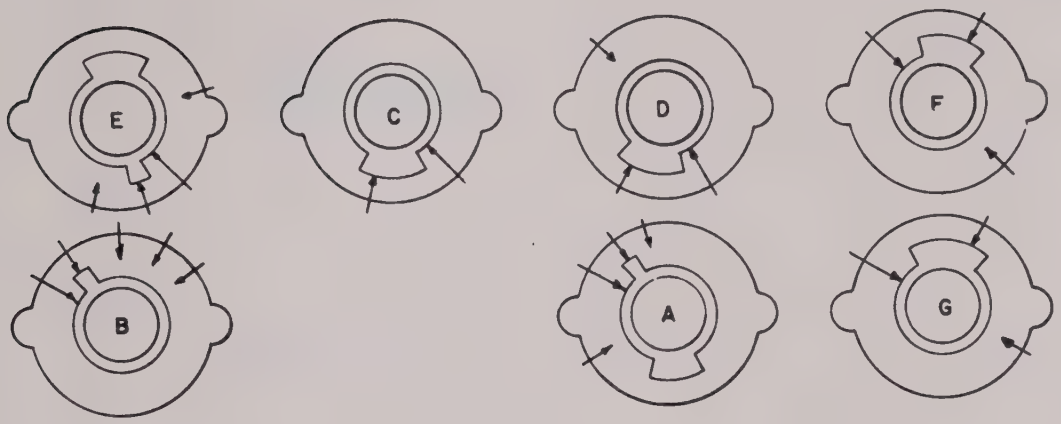
COMPONENT LOCATION OVEN REFERENCE

400-125

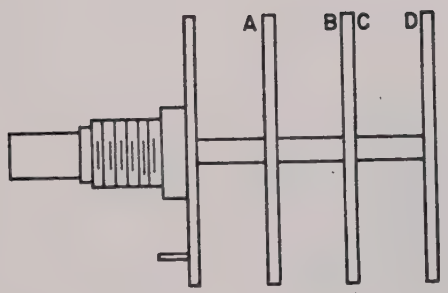
S2



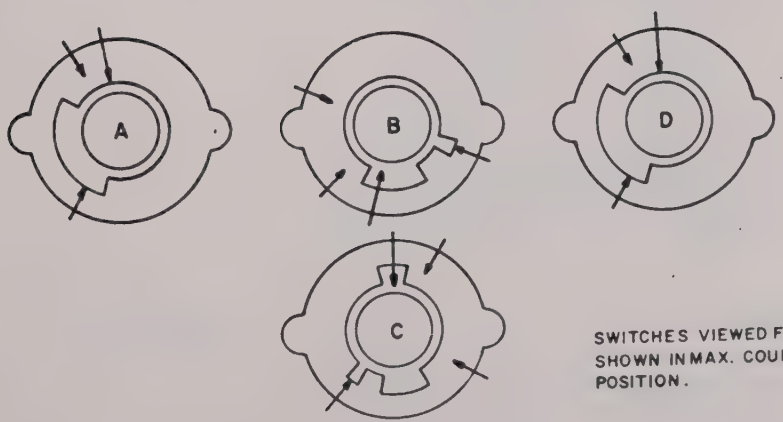
RANGE SWITCH
(PART 240-045)



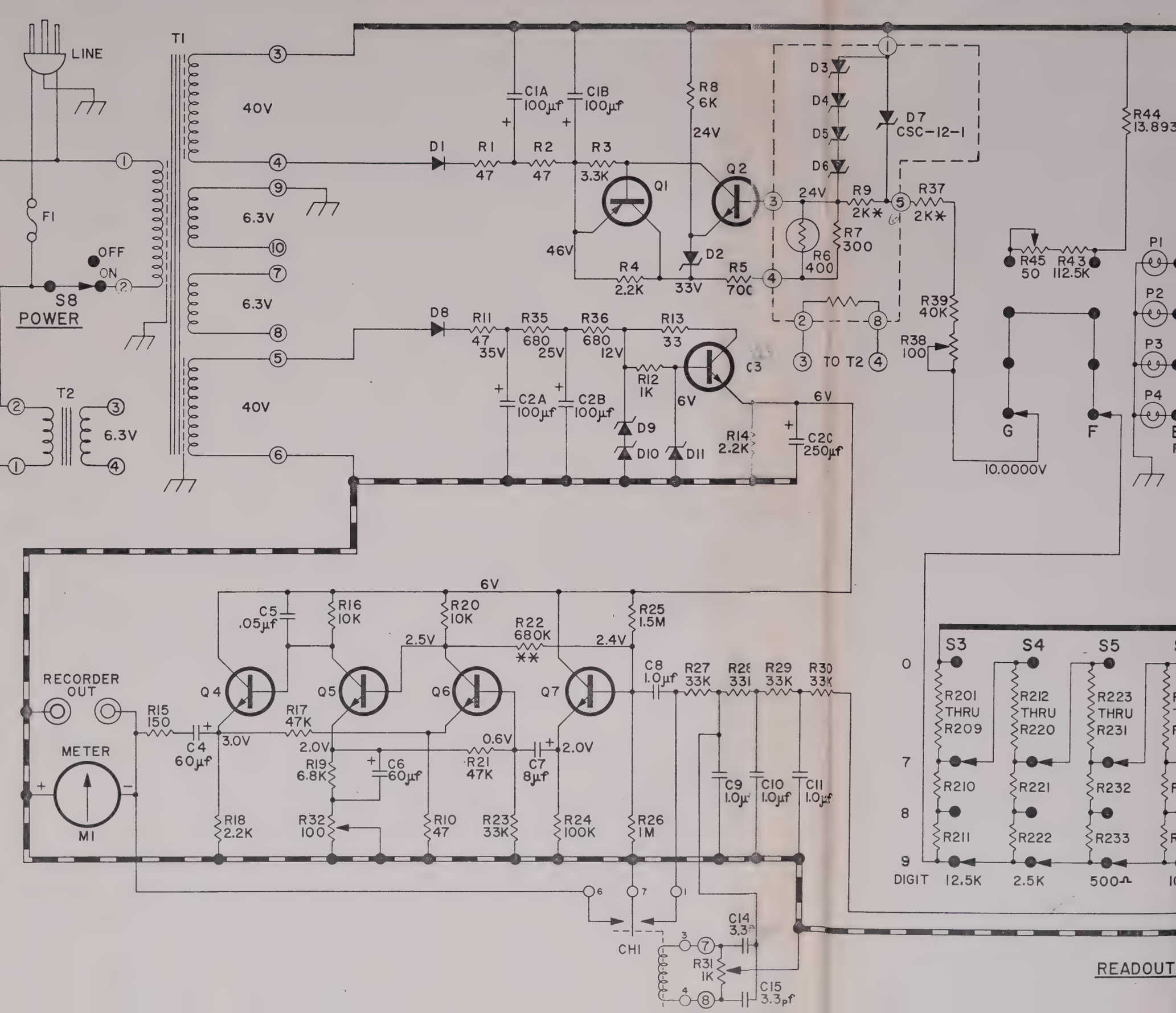
S1



NULL SWITCH
(PART 240-044)



SWITCHES VIEWED FROM KNOB END
SHOWN IN MAX. COUNTER CLOCKWISE
POSITION.


LINE
T1
40V
6.3V
6.3V
40V
6.3V
T2
F1
OFF
ON
S8
POWER
C1A 100μf
C1B 100μf
D1
R1 47
R2 47
R3 3.3K
Q1
Q2
R8 6K
24V
46V
R4 2.2K
D2
33V
R5 700
D3
D4
D5
D6
D7 CSC-12-1
24V
R9 2K*
R37 2K*
R6 400
R7 300
R44 13.893
R45 50
R43 112.5K
P1
P2
P3
P4
G
F
10.0000V
R39 40K
R38 100
TO T2
D8
R11 47 35V
R35 680 25V
R36 680 12V
R13 33
C3
R12 1K
6V
C2A 100μf
C2B 100μf
D9
D10
D11
R14 2.2K
C2C 250μf
6V
C5 .05μf
R16 10K
R20 10K
R22 680K **
R25 1.5M
2.5V
2.4V
Q4
Q5
Q6
Q7
C8 1.0μf
R27 33K
R28 331
R29 33K
R30 33K
RECORDER OUT
METER
M1
R15 150
C4 60μf
3.0V
R17 47K
2.0V
R19 6.8K
C6 60μf
0.6V
R21 47K
C7 8μf
2.0V
C9 1.0μf
C10 1.0μf
C11 1.0μf
R18 2.2K
R32 100
R10 47
R23 33K
R24 100K
R26 1M
S3
S4
S5
0
7
8
9
R201 THRU R209
R210
R211
R212 THRU R220
R221
R222
R223 THRU R231
R232
R233
DIGIT 12.5K
2.5K
500Ω
CH1
C14 3.3Ω
R31 1K
C15 3.3pf
READOUT

REPLACEMENT PARTS LIST (Continued)

Reference or Quantity	Description	Stock Number
Reference Supply Sub-Assembly, 400-125		
R1, R2	Resistor, FC, 47Ω, 10%, 1/2W	201-470
R3	Resistor, FC, 3.3KΩ, 10%, 1/2W	201-332
R4	Resistor, FC, 2.2KΩ, 10%, 1/2W	201-222
R5	Resistor, DC, 700Ω, 1%, 1/2W	205-032
R8	Resistor, DC, 6KΩ, 1%, 1/2W	205-042
C1A, C1B	Capacitor, Dual Electrolytic, 100-100 mfd, 50 vdc	222-013
D1	Diode	216-025
D2	Zener Diode	216-008
Q1	Transistor, PNP Silicon	215-036A
Q2	Transistor, NPN Silicon	215-015A
	Zener and Oven Assembly	400-126

REPLACEMENT PARTS LIST (Continued)

Reference or Quantity	Description	Stock Number
Amplifier Sub-Assembly, 400-106		
R10, R11	Resistor, FC, 47Ω, 10%, 1/2W	201-470
R12	Resistor, FC, 1KΩ, 10%, 1/2W	201-102
R13	Resistor, FC, 33Ω, 10%, 1/2W	201-330
R14, R18	Resistor, FC, 2.2KΩ, 10%, 1/2W	201-222
R15	Resistor, FC, 150Ω, 10%, 1/2W	201-151
R16, R20	Resistor, FC, 10KΩ, 10%, 1/2W	201-103
R17, R21	Resistor, FC, 47KΩ, 10%, 1/2W	201-473
R19	Resistor, FC, 6.8KΩ, 10%, 1/2W	201-682
R22	Resistor, FC, 680KΩ, 10%, 1/2W	201-684
R23, R27, R28, R29, R30	Resistor, FC, 33KΩ, 10%, 1/2W	201-333
R24	Resistor, FC, 100KΩ, 10%, 1/2W	201-104
R25	Resistor, FC, 1.5MΩ, 10%, 1/2W	201-155
R26	Resistor, FC, 1.0MΩ, 10%, 1/2W	201-105
R35, R36	Resistor, FC, 680Ω, 10%, 1/2W	201-681
R31	Resistor, Variable, 1KΩ	210-010
R32	Resistor, Variable, 200Ω	210-009
C2A, C2B, C2C	Capacitor, Triple Electrolytic, 100-100-250 mfd, 50-50 vdc	222-014
C4, C6	Capacitor, Tantalum, 60 mfd, 6 vdc	223-008
C5	Capacitor, Disc, .05 mfd, 75 vdc	220-002
C7	Capacitor, Tantalum, 8.2 mfd, 20 vdc	223-009

REPLACEMENT PARTS LIST (Continued)

Reference or Quantity	Description	Stock Number
Amplifier Sub-Assembly, 400-106 (continued)		
C8, C9, C10, C11	Capacitor, Mylar, 1 mfd, 100 vdc	220-033
D8	Diode	216-025
D9, D10	Zener Diode	216-004C
D11	Zener Diode	216-004A
Q3, Q4, Q5, Q6, Q7	Transistor, NPN Silicon	215-015A
CH1	Chopper	230-004
5	Pad, Transistor	218-004
1	Socket, 7-pin	260-011
C14, C15	Capacitor, 3.3 mmf	220-007

REPLACEMENT PARTS LIST (Continued)

Reference or Quantity	Description	Stock Number
Calibration Board Sub-Assembly, 400-108		
R39	Resistor, WW, 40KΩ, .05%, 1/3W	203-503
R43	Resistor, WW, 112.5KΩ, .02%, 1/3W	203-504
R44	Resistor, WW, 13.893KΩ, .02%, 1/3W	203-501
R46	Resistor, DC, 9KΩ, 1%, 1/2W	205-001
R47	Resistor, DC, 900Ω, 1%, 1/2W	205-039
R48	Resistor, DC, 100Ω, 1%, 1/2W	205-036
R49	Resistor, DC, 90KΩ, 1%, 1/2W	205-004
R50, R54	Resistor, DC, 900KΩ, 1%, 1/2W	205-002
R51, R55	Resistor, DC, 9MΩ, 1%, 1/2W	205-005
R52	Resistor, DC, 11KΩ, 1%, 1/2W	205-008
R53	Resistor, DC, 300KΩ, 1%, 1/2W	205-009
R57, R58, R59	Resistor, WW, 600KΩ, .02%, 1/3W	203-551
R60	Resistor, WW, 179.975KΩ, .02%, 1/3W	203-521
R61	Resistor, Variable, 10Ω	210-015
R62	Resistor, WW, 19.995KΩ, .02%, 1/3W	203-502
R45	Resistor, Variable, 50Ω	210-014
R38	Resistor, Variable, 200Ω	210-009
R56	Resistor, Variable, 100Ω	210-011

REPLACEMENT PARTS LIST (Continued)

Reference or Quantity	Description	Stock Number
Kelvin-Varley Divider, 12,500Ω, Sub-Assembly, 400-115**		
S3	Switch, Rotary	240-046
R201-R211	Resistor, WW, 12.5KΩ, .01%, 1/3W	203-303
Kelvin-Varley Divider, 2,500Ω, Sub-Assembly, 400-116**		
S4	Switch, Rotary	240-046
R212-R222	Resistor, WW, 2.5KΩ, .05%, 1/3W	203-132
Kelvin-Varley Divider, 500Ω, Sub-Assembly, 400-117**		
S5	Switch, Rotary	240-046
R223-R233	Resistor, WW, 500Ω, .05%, 1/3W	203-102
Kelvin-Varley Divider, 100Ω, Sub-Assembly, 400-110		
S6	Switch, Rotary	240-046
R234-R244	Resistor, WW, 100Ω, .1%	203-106
Kelvin-Varley Divider, 20Ω, Sub-Assembly, 400-111		
S7	Switch, Rotary	240-046
R245-R255	Resistor, WW, 20Ω, .5%	203-107
R64	Resistor, Variable, WW, 50Ω	210-016
R63	Resistor, FC, 10%, 1/2W	***

REPLACEMENT PARTS LIST (Continued)

Reference or Quantity	Description	Stock Number
T1	Power Transformer, 115 vac, 50-60 cps Power Transformer, 230 vac, 50-60 cps	235-014 235-016
C12	Capacitor, Disc, .02 mfd, 1K vdc	220-001
F1	Fuse, 3 AG, 1/8 amp	261-001
1	Fuse Holder	261-002
1	Line Cord	264-001
1	Strain Relief	283-001
5	KVD Switch Readout Dial	400-112
1	KVD Pot Readout Dial	400-113
S1	Switch, Rotary, Null	240-044
S2	Switch, Rotary, Range	240-045
S8	Switch, Toggle, SPST	240-047
S9	Switch, Toggle, DPDT	240-026
M1	Meter, 100-0-100 micro-amp	250-008
1	Bezel, meter	250-009
1	Terminal Post, Red	263-105
2	Terminal Post, Black	263-106
R33	Resistor, FC, 68Ω, 10%, 1/2W	201-680
4	Lamp, Decimal	400-114
2	Knob, Range & Null	214-010
6	Knob, KVD	214-011
1	Cover, Instrument (B only)	310-080
1	Handle, Instrument (B only)	285-004

REPLACEMENT PARTS LIST (Continued)

Reference or Quantity	Description	Stock Number
4	Feet, Rubber	283-003
1	Test Lead, Red	264-003
1	Test Lead, Black	264-002
C13	Capacitor, 0.1 mfd, 1000 vdc	220-040

NOTES

* (A) D7, the reference Zener diode, is carefully selected and stabilized by Calibration Standards Corporation. R9 is a precision wire wound resistor carefully selected to control the current through the reference diode, D7. R37 is a precision wire wound resistor, factory selected to drop the reference voltage from 13.5 ±5% vdc to 10.000 vdc. Failure of these components is extremely remote. It is recommended that the instrument be returned to the factory if a problem is suspected.

** (B) The resistors forming the Kelvin-Varley decks are factory matched to achieve an overall accuracy better than ±.002% absolute. The 12.5K deck resistors are matched to .001% of each other; the 2500Ω and 500Ω to within .0025%. When ordering, include instrument model and serial number.

*** (C) R64 is matched to the balance of the Kelvin-Varley divider by means of R63. R63 is factory selected and may vary in value from instrument to instrument.

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